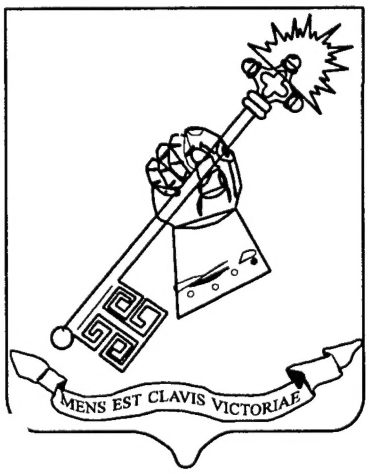
COMPOSITE WARFARE COMMANDER (CWC) IMPLICATIONS FOR FORCE XXI TACTICAL COMMAND AND CONTROL (C2)

A Monograph
By
Major William G. Braun III
Aviation



School of Advanced Military Studies
United States Army Command and General Staff College
Fort Leavenworth, Kansas

First Term AY 95-96

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE

3. REPORT TYPE AND DATES COVERED
MONOGRAPH

4. TITLE AND SUBTITLE
COMPOSITE WARFARE COMMANDER (CWC) IMPLICATIONS FOR FORCE XXI TACTICAL COMMAND AND CONTROL (C^2)

5. FUNDING NUMBERS

6. AUTHOR(S)
WILLIAM G. BRAUN, III
MAJ, US ARMY

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
School of Advanced Military Studies
Command and General Staff College
Fort Leavenworth, Kansas 66027

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Command and General Staff College
Fort Leavenworth, Kansas 66027

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE:
DISTRIBUTION UNLIMITED.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

SEE ATTACHED

14. SUBJECT TERMS
COMPOSITE WARFARE
AUTOMATED BATTLE COMMAND SYSTEM
BATTLE COMMAND
COMMAND AND CONTROL
FORCE XXI
FUNCTIONAL COMMAND
ARMY AUTOMATION
~~ACCESSAT~~
ARMY TACTICAL COMMAND + CONTROL SYSTEM

15. NUMBER OF PAGES
59

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UNLIMITED

SCHOOL OF ADVANCED MILITARY STUDIES

MONOGRAPH APPROVAL

Major William G. Braun III

Title of Monograph: Composite Warfare Commander (CWC) Implications for Force XXI Tactical Command and Control (C2)

Approved by:

Richard M. Swain, Ph.D. — Monograph Director

COL Danny M. Davis, MA, MMAS — Director, School of Advanced Military Studies

Philip J. Brookes, Ph.D. — Director, Graduate Degree Program

Accepted this 14th day of December 1995.

ABSTRACT

Composite Warfare Commander (CWC): Implications for Force XXI Tactical Command and Control (C2) by MAJ William G. Braun III, USA, 46 pages.

This monograph examines the Navy's Composite Warfare Commander doctrine, and attempts to determine potentially relevant adaptations for Army Force XXI tactical command and control.

Initially the monograph conducts a detailed study of the Navy's Composite Warfare Commander doctrine, the Army's Automated Battle Command System architecture, and Army Battle Command doctrine. These studies are compared and analyzed to determine implications of: command by negation philosophy as a guide to senior commanders, the different environments in which the Army and Navy command and control systems operate, and implications of a functional command model, on future Army tactical command and control.

It concludes that the Army should adopt the command by negation philosophy as a tenant to Battle Command doctrine. This tenet focusing on the senior commander's responsibility to establish an environment conducive to controlling and encouraging subordinate initiative. Second, it suggests the Army should resource the function of directed telescopes and liaison officers. Third, it recommends the Battle Labs explore organizational structures based on functional commands, and test those structures for validity. Finally, it admonishes that change should only progress at a pace that advances in technology and funding can support.

Key Words: Composite Warfare Commander, Automated Battle Command System, Battle Command, Command and Control, Force XXI, Functional Command.

Table of Contents

Introduction

The explosion in technology in the second half of the 20th Century has changed the way the world operates. Technology has provided ready access to rapid travel, instant information, and efficient data processing to nearly every major institution in the modern world. The military services are no exception. The U.S. Army tasked Training and Doctrine Command (TRADOC) to "initiate a campaign to evaluate new experiments that will leverage superior American Technology to build the Army of Tomorrow."[1] In response to that tasking, TRADOC attempted to portray a vision of future conflict and address appropriate Army development to respond to those environments. TRADOC analysts concluded that technology and doctrine are the precursors of change in warfare. They went on to say the dramatic and rapid developments in both technology and doctrine have resulted in a revolution in military affairs.[2] Based on the "premise that doctrine must be the engine that drives the exploitation of technology",[3] TRADOC has explored implications of the revolution in military affairs and captured their findings in a conceptual framework called Force XXI.

Advancements in aerospace, information, and weapons technologies (to name a few) have contributed significantly to this revolution. Just these three fields of technological advancement have influenced each of the services and each of the branches. In the Army, these areas of technological advancement have affected the functions of maneuver, firepower, protection, and leadership. Together these elements, in combination, constitute combat power. Leadership is considered the most essential element.[4] Leadership acts through its integrating, decision making, and motivating

functions. Among other things, leadership is taking responsibility for decisions, and inspiring and directing assigned forces toward the purposeful end of those decisions.[5]

The execution of these leadership functions, by a properly designated commander, over assigned forces to accomplish the units mission is called command and control.[6] To achieve victory at minimum cost, the modern commander must bring to bear, violently, the combined elements of combat power. He accomplishes this violent application of combat power through a command and control system. The command and control (C2) system encompasses all the elements of organization, procedure, and technology that assist the commander in executing his decision making, synchronizing, and motivating responsibilities.[7] The C2 infrastructure provides for the basic functions of collecting, processing, disseminating, displaying and protecting information.[8] Advancements in sensory, communications, and computer technology, particularly as they relate to the command and control functions of leadership, will influence military operations greatly[9] and "undoubtedly unlock the full potential of Force XXI Operations".[10]

As it relates to C2, the Force XXI concept can be explored in two areas. The first is Battle Command. In both current doctrine and future concept, Battle Command involves the separation of the leadership and decision making functions inherent in command, from the rest of the infrastructure of the C2 system. The second area addressed by the Force XXI concept is the automated infrastructure of a C2 architecture. The Army has adopted an automated architecture, known as the Army Battle Command System, to address the C2 infrastructure needs of the Force XXI commander. Martin Van Creveld sums up the paradoxical realities of command as: a demand for more

information in the endless quest for certainty[11], and a realization that modern forces are not "one-wit more capable of dealing with the information needs of the command [in achieving certainty] than were their predecessors ...a millennium ago."[12]

The Navy, like the Army, is coping with the realities of the explosion in information technologies. The Navy C2 infrastructure has already achieved many of the data communications, sensor fusion, automated decision aid, positive location and visual display capabilities set forth in the Army Battle Command System (ABCS) Master Plan. Since the early 1980's, the Navy has adopted a C2 doctrine for fleet defense known as the Composite Warfare Commander (CWC) to exploit these information technology capabilities.

This year the Army is going to rewrite FM 100-5. As this is occurs, the Battle Command Labs at Fort Leavenworth, Fort Gordon, and Fort Huachuca, will be testing the art and science of the doctrinal and technical hypotheses laid out in the Force XXI concept.[13] As the hypotheses are accepted and rejected, they will be formalized into doctrine, postponed for refinement, or scrapped as untenable. As the process continues, TRADOC will explore new doctrinal and technical solutions to meet the challenges of the Force XXI concept.

As part of this process, the Army should examine the Navy's CWC doctrine to determine what relevance it may have to the Army; and how any relevant elements might be adopted for testing in the Battle Command Labs. By examining and comparing the Navy's CWC architecture, the Army's ABCS architecture, and the Army's battle command doctrine, two Naval models with potential relevance to the Army are revealed:

functional command organization, and emphasis on the procedure of command by negation for senior commanders.

A detailed examination of the two systems reinforces the idea the Army is on the right track with the ABCS C2 Architecture. Army doctrine has formalized the need for subordinates to: visualize the battlefield, rely on intuition, and take initiative within the senior commander's intent. The future concept of Force XXI expands these points to addresses the senior commander's dilemma: how to cope with the volumes of information presented by the C2 system and determine when to intervene in subordinate activity (deciding when to decide). Specifically, the concept addresses the philosophy of 'negation' when dealing with the huge volumes of information available in future C2 Architectures.

The Army needs to take the final step of sanctioning the 'command by negation' philosophy as the approved way to interact with subordinates. This can be done by adopting the command by negation concept as a tenet of battle command. The negation tenet will highlight the notion that, at senior levels, the real decision is knowing when to decide. Organizationally the Army should experiment with a functional command structure. The structure should be based on tailored forces, made up of 'building block' units. Each building block unit should be capable of independent operation and discrete task accomplishment. To make these tailored functional units work, the Army must adjust current staff procedures. The Army must develop staff procedures which balance execution functions with planning and preparation. This is best done by institutionalizing staff exposure to subordinate units and their environment. Two procedures

recommended for accomplishing this are: the use of staff officers as directed telescopes, and the development of informal communications networks via matrixed concurrent planning cells.

Many of the assertions made may find applicability at strategic command and policy levels. However, the focus of the argument will rest with tactical commanders. "The tactical level of war is concerned with the execution of battles and engagements. ...Tactical-level commanders are moved in and out of battles by higher commanders"[14] "The tactical commander's decisions are focused on execution of a specific mission or plan ...within the intent of the commander two levels up."[15] It is important to recognize that the tactical distinction is not based on force size, but the function of the unit . Which organizations constitutes the tactical level of command is dependent on the mission and political environment. The Army Battle Command Master Plan identifies the tactical environment for most scenarios to be corps and below.[16]

Composite Warfare Commander[17]

The Composite Warfare Commander (CWC) concept outlines the U.S. Navy's local command concept. It establishes relationships between commanders to facilitate the defense of a naval force. The command and control (C2) architecture clearly delineates the two generic missions of a naval force: offensive operations and force security. The CWC is responsible for the latter, and his mission is subordinate to the mission of the former.

The concept calls for the Officer in Tactical Command (OTC) to retain central command authority. He is responsible for accomplishing the force projection or strategic

mission of the naval force. Because of this overall responsibility, and the overriding importance of the offensive mission objective, consideration for the OTC mission takes priority over the force security mission of the CWC. In smaller battle groups the OTC and CWC are the same commander. In larger battle groups (usually consisting of two or more carriers) the OTC and CWC may be separate commanders. The decision as to whether the OTC and CWC are separate commanders is a function of mission complexity, communications packaging, and span of control.

To accomplish the Tactical Sea Control (self defense of the force) mission the CWC typically performs the following primary duties:

a. Arrange desired information exchange with higher authority.

b. Receive, evaluate, display and pass information to external sources.

c. Establish force C2 policies

d. Resolve conflicts between subordinate warfare commanders.

e. Construct and display composite picture of tactical situation.

f. Act as net control on forces command nets and determine primary C2 vehicles.

"The nature of the maritime environment, characterized by vast distances, wide dispersion of forces, complexity of a three-dimensional threat (surface, air, subsurface), and C3 [command, control, and communications] challenges, influences the selection of a C2 structure."[18] "The organizational structure employed for delegation of defensive functions is based on the composite warfare commander (CWC) concept."[19] Under a CWC there are typically three subordinate commanders and three staff functions present.

Figure 1 delineates the title, abbreviation, and generic duties of these fundamental positions.

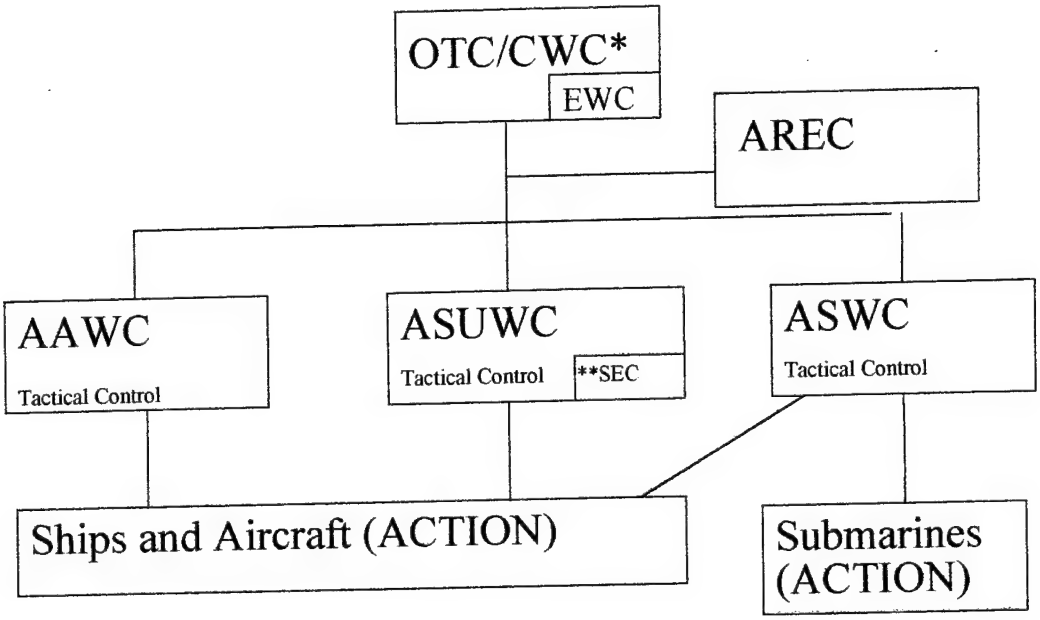
SUBORDINATE WARFARE COMMANDERS and STAFF FUNCTIONS

Anti Air	AAWC	Collect, evaluate, & disseminate tactical information Tactical control of resources, autonomously initiate action with CWC authorization
Anti Surface	ASUWC	
Anti Submarine	ASWC	
Submarine Element Coordinator	SEC	Staff element responsible for management and coordination Only executes policy (electro magnetic and acoustic)
Air Coordination Element	AREC	
Electronic Warfare Coordinator	EWC	

Figure 1.

The command structure for the fundamental command and staff elements represented in figure 1 are depicted in the following organizational wire diagram (figure 2).

CWC Command Sturcture



* OTC & CWC may be separate entities at the command level
** The SEC reports directly to the OTC/CWC for matters of submarine safety and prevention of mutual interference

FIG. 2

In addition to the subordinate commanders and the basic staff functions (SEC, AREC, and EWC) the CWC may designate any number of Functional Commanders. The use of additional functional commanders is optional. Their use is dependent on a careful assessment of the mission, enemy, and capabilities of the naval force. It is also critical to point out that a single ship commander may be designated to multiple command positions. In addition, each position has a designated alternate who assumes the primary commander's duties in the event the primary commander is destroyed, rendered incapable

of performing the mission due to degraded communications, or chooses to pass off the command for a designated period because of competing demands for resources.

Several common functional commander designations are:

a. Deception Commander.

b. Screen Commander (SC).

c. Maneuvering Coordinator.

d. Helicopter Element Coordinator (HEC).

e. Sector Warfare Commander.

To reduce the confusion that might be generated by alternating call signs among the different responsibilities, the Navy standardized the administrative call signs of each function. They are used as common 'CB Handles' in all U.S. naval fleets. The nature of the battle groups communications makes this system both convenient and sound. Unlike the Army, all U.S. Navy communications between ships are secure. Even the UHF communication, used primarily with the helicopter force, is secure. Figure 3 provides a listing of the standardized callsign of the primary and alternate functions.

Communications Callsigns

Abbreviation	Callsign	Alternate's Callsign
Fleet CDR	AA	--
CWC	AB	AV
ASWC	AX	AY
AAWC	AW	AC
ASUWC	AS	AT
EWC	AE	AZ
AREC	AR	AU*
HEC	AC	AH
SEC	AN	AD
* Second carrier in a two carrier group AREC callsign.		

FIGURE 3

The final concept required to understand the CWC philosophy is the Navy's notion of delegation of authority. Because the "individual warfare commanders and coordinators are required to recognize and effectively counter rapidly developing threats, especially in the multi-threat environment",[20] they are expected to act independently. While the OTC and/or CWC has the option of using a range of authority from full to no delegation, Navy tradition favors extensive delegation.

The ***least desirable*** level of delegation is ***direct control***. This form is generally used when rules of engagement are stringent, or when the CWC does not feel comfortable with delegating authority to an unknown subordinate. The most often used form of control is called ***control by negation*** (veto). When exercising this form of control, the subordinate commander is required to act independently in response to the situation. If the CWC disagrees with the action, he vetoes it. This form of control allows for the most flexible and timely response to developing threats.

The apparent lack of command unity and the potential for resource competition, is overcome during work-ups prior to sea duty. During these work-ups the CWC personalizes force procedures. He provides his interpretation of actions to be taken under a number of situations. While the CWC concept appears alien to the Army officer, it has been around and worked remarkably well for most of the Navy's recent history.

Automated Battle Command System (ABCS)

To highlight the unique functions of C2, the Army separated the functions of leadership and decision making from the systems architecture which facilitates those functions. The term Battle Command captures the personalized leadership and decision making functions associated with C2. The Army Battle Command System (ABCS) represents the automated systems architecture to support those functions on the future battlefield. Before discussing the personal functions performed by the commander on the modern battlefield, it is necessary to gain an understanding of the technical environment in which he will execute those functions. "The Army's vision of future battle command

is reflected in the ABCS concept. This system capitalizes on... what we now call Information-Age technology."[21]

To gain a better understanding of the current ABCS, it is necessary to follow its development from its historic antecedents known as The Army Command and Control System (ACCS) and The Army Tactical Command and Control System (ATCCS: pronounced A-Ticks). ACCS was "both a system and a concept that encompassed elements of doctrine, training, leader development, organization and material."[22] At strategic levels the ACCS interfaced with the Worldwide Military Command and Control System (WWMCCS) through the Army WWMCCS Information System (AWIS). "The AWIS passes information between the NCA [National Command Authority], Army Strategic planners, and theater commanders."[23] The ATCCS represented the tactical levels of automated Army C2 at corps and below. The ATCCS architecture partitioned C2 into five battlefield functional areas (BFAs). Each BFA was further divided into three classes of subsystems: force level control systems (FLCS), functional control systems and subordinate control systems.

The first of these control systems (FLCS) provided for the command functions of deciding and directing assigned forces. In the ACCS concept these remained largely man-in-the-loop activities. In other words, the commander did the deciding and, if automation was involved at all, it took the form of transmission and display of orders.

The functional control system encompassed the unique automation requirements associated with each battlefield functional area (BFA). The BFAs represented in ATCCS were maneuver, fire support, intelligence, air defense, and combat service support. Each

of these BFAs had a unique set of associated automation hardware and software to support it. The maneuver function had the Maneuver Control System. The fire support function had the Tactical Fire Direction System (and the Advanced Field Artillery Tactical Data System). The Intelligence function had the All Source Analysis System. The air defense system had the Forward Area Air Defense Command, Control, and Intelligence System. And, the combat service support function had the combat service support control system.[24]

Subordinate systems provided for unique (usually branch specific) requirements which BFA automation could not perform. The aviation mission planning system (AMPS), and the Integrated Vehicular Information System (IVIS), were examples of these subordinate systems.

The ATCCS architecture calls for linkage between these functional area systems through three sets of communications means: the combat net radio, the area data distribution system, and the area common user system. Under the ATCCS concept, the three basic communications media remain constant irrespective of the communications technology developed to fill them. Currently, the hardware used to accommodate the combat net radio medium are the single-channel ground and airborne radio system (SINCGARS), and the improved high frequency radio system (IHFRS). The area common user systems include: mobile subscriber equipment (MSE) and satellite communication links. The enhanced position and location reporting system (EPLRS) and the joint tactical information distribution system (JTIDS) provide the ATCCS

architecture the larger data communications mediums require of the army data distribution system. [25]

The Army's ACCS strategy embraced an iterative process of fielding BFA unique hardware and software, then refining the connections between BFAs and vertical levels of automated C2 through a process of continuous enhancement. In the end, the goal of ATCCS strategy was to evolve a set of common hardware and software (CHS) that would meet all the needs of Army automation from corps level to weapons platform. This CHS would provide joint and strategic interoperability through standard message formatting and protocol structure compatible with AWIS. [26]

"The Army's ATCCS cost estimate, as of June 1992, was about $20.5 billion. About 9.5 billion was for the five command and control segments and $11.0 billion for the three communications segments."[27] The current and future fielding strategy for ATCCS was not without its problems. The computer systems initially fielded in the maneuver functional area were declared "obsolete" and the portable CHS version was "found to be inadequate" by the Army. The Government Accounting Office expressed concerns about proceeding with procurement before demonstrating that all segments of the system could exchange data.[28] In addition to these specific issues, the ATCCS concept never attempted to achieve: a visual display to facilitate tactical interpretation, seamless automated linkage to higher and lower levels, or an ability to accommodate sensor to shooter linkages. With relatively few exceptions the exchange of information was conducted in message text format. Vertical linkages to AWIS and subsystems were manual, and sensor to shooter linkage bypassed the conceptual architecture.

The affects of implementing an automated C2 architecture in the Army has several subtle, and not so subtle effects on command. The first effect is an expansion on a theme started in the McNamara years, a continued emphasis on statistics and quantifiable data as a sole means of information gathering and control. Those who rely on automated systems decision making, information gathering, and control, leave little room for the subjective analysis of the affects of morale, culture, historical context or passion.[29]

Because the linkages of ATCCS were not mature enough to accommodate extensive automated interfaces at the subordinate system level, any request for information required manual inputs. This placed a great burden on subordinates to input manually voluminous data/information, often without a clear understanding of what value the information provided.

Finally, the stove-pipe design of the BFAs encourages a focus on the planning and preparation phases of an operation, at the expense of the execution phase. The time and coordination required to make the interface both vertical/within and horizontal/between the BFA systems was only available during the planning phase of an operation. Message text presentation of information and manual interface between systems were simply not fast enough to warrant the resource burdens of automation during execution. The physical location of the ATCCS hardware has centralized the availability of critical information. The limited ability of the system to seek, screen, and display information alienates the Commander from the battlefield. The Commander can be captured by the system and tied to the command post, during the execution phase of combat.

The challenges of future C4 requirements are not much different from those in the past. The "C4 systems exist to extend the flow of information between warriors."[30] The purpose of the ABCS is to provide the battle commander an automated means to fulfill his responsibilities of coordinating combat functions, and to "synchronize battle effects in time, space, and purpose."[31] To achieve this coordination and synchronization, doctrine identifies several foundation principles and five operational functions that a C4 system must embody. "The foundation for C4 is the continuous, uninterrupted flow and processing of information in support of warrior planning, decision, and execution."[32] The four functions of a C4 system are the collection, transport, processing, dissemination and protection of that information.[33]

In the end, "an ideal command system, ..., should be able to gather information accurately, continuously, comprehensively, selectively, and fast."[34] If the system is working well, the result will be: unity of effort, exploitation of total force capability, properly positioned critical information, and information fusion. This will take the form of automated assistance in mission planning, rehearsal, preparation, assessment, and updates.[35] To accomplish these goals, future systems must "reveal new or increased, emphasis on: capabilities to move information globally, ...capture information once, in a format that can be shared throughout the force, ...[and] keep mobile commanders and staffs informed and in control of forces."[36] To accomplish these goals, the automated system must provide distributed communications to broadcast synthesized information. The information must be tailored to the level of command and geographic responsibility of the unit it supports. The systems design must accommodate access to space based

sensor and communications systems, not only to effect global information access but to serve mobile command posts. Above all, future C2 architectures must advance joint interoperability in compliance with DOD policy.[37]

To meet these challenges, the Army published the Army Battle Command Master Plan to replace the Army Command and Control Master Plan. The Army Battle Command Master plan provides a roadmap for development of future Army battle command architectures. The Army Battle Command System (ABCS), proffered by the master plan, "represents a marked departure from Army doctrine for command and control in the cold war era, ..."[38] The ABCS master plan attempts to continue the evolution of Army C2 into the 21st century by addressing the shortfalls of the ATCCS system and adapting to the new challenges presented by Force XXI command, control, communications and computer (C4) requirements.

The Army Battle Command System will provide the framework for today's digitized battlefield. Digitizing the battlefield will provide commanders from corps to company the capability to command and control (C2) mobile operations from a variety of platforms.[39] The ABCS structure encompasses all levels of control, from strategic interface, to direct links between sensors and shooters. Conceptually, all of this capability will be linked to an open architecture Global C2 System (GCCS).[40] "The GCCS is the cornerstone of the C4I for the Warrior concept; ...[objectively it will provide] a common operational picture to support situational awareness to the joint warfighter."[41]

There are five differences between the ATCCS concept and the ABCS concept. The first is the subtle shift of the ATCCS objective system composed of common hardware and software, to the ABCS system functioning in an Army common operating system environment.[42] The significance of this change is profound. Under the ABCS concept the BFAs are no longer required to use identical hardware or software. Each can maximize the efficiencies of rapidly developing technology to meet their distinct needs. For example, the CSSCS deals in large volumes of information on status of different classes of supply, and historic usage records on equipment. This information has a relatively long shelf life in the automated world. Summaries of information collated and passed every 12 to 24 hours would meet the needs of the logisticians and constitute a substantial improvement on the current logistics reporting system. On the other hand, the ASAS of the intelligence community or the FAADC2I system of the air defense functional area requires the near real-time reporting of discrete pieces of information. For an moving vehicle or aircraft to be valuable as an automated target, data representing its location, speed, and direction must be passed directly to another system (preferably a shooter) in fractions of a second. This is particularly critical if the data is gathered from multiple sensors and fused at a central processor. Disparities in the type and volume of data, and the speed with which it must be transmitted, significantly alters the systems requirements and design of receiving central processors. Since CHS is no longer a requirement, the proponents of each BFA can optimize its hardware and software solutions to meet their unique challenges.

To achieve compatibility, each BFA system is required to incorporate the features of what is known as an open architecture design. This means that no matter how data is received or manipulated within the system, it must leave the system in a recognizable format over a standard interface. This requirement stipulates standard hardware connections, standard communications protocols, and standard data conversions. These conventions are set forth by the Army digitization Office (ADO), the enabler responsible for coordinating these standards functions.[43] The networks that result from open systems architectures are called information grids.[44]

The second emphasis of ABCS is an emphasis on commercial standards. Aside from a stated desire to use ADA language whenever feasible, ABCS embraces using commercial standards for all hardware and software. This facilitates the integration and exploitation of advancements in technology with military application when they are discovered. From the connections to civilian produced communications and computer equipment, to the protocols and programs used on them, the Army is attempting to be interoperable. For similar interoperability reasons, and because of the significant cost savings associated with procurement and maintenance, ABCS is maximizing the use of commercial off-the-shelf (COTS) technology. The ATCCS strategy demanded CHS meet the stringent requirements of military specifications. The ABCS strategy accepts some risk in hardening and security, required by military specification, to exploit the timeliness and cost benefits of commercially available technology.[45]

The fourth difference between the ATCCS and the future C2 concept as implemented by ABCS is "a focus on providing a common operational picture to support

situational awareness".[46] This is accomplished by displaying information visually in near-real time. In the maneuver functional area, the display will visually represent friendly and enemy locations, graphic control measures, and resource status.[47] This capability exploits new advancements in fusion technology. Fusion is the ability of a central processor to receive data inputs from multiple sensors and merge them into an accurate whole. This capability is expected to greatly enhance a commander's ability to visualize the battlefield.

The final advancement from the technologies available in ATCCS is the use of automated decision supports to help screen information and automate routine decision making functions. In the past all decisions were made through a man-in-the-loop. A commander would review information available in ATCCS, make a decision, and the results of the decision were converted by an operator to a format recognizable to a subordinate (order, message, etc.) for action. With the increased capability available in decision support aids and artificial intelligence, the machine is now capable of making routine decisions.[48]

The automation nodes of the ABCS architecture are linked together by the communications structure. Just as the spinal cord links the brain with the eyes, ears, nose, and appendages, to exercise the will of the individual, the communications network links the processor nodes at command posts with sensor and weapons system platforms to exercise the will of the commander. "Communications are paramount ...information requirements ...will vary greatly, depending on the types of missions. The existence of assured communications, however, directly relates to [all] mission success."[49] Assured

communications are a requirement during all stages of an operation, and their critical importance is recognized by doctrine.[50]

Current communications systems, used to meet the requirements of ABCS, were discussed earlier in the description of ATCCS. In addition to those systems, ABCS incorporates a global linkage via satellite systems, and access to commercial phone networks using a secure telephone unit. The single channel anti-jam manportable (SCAMP) terminal links MILSTAR satellites with the ATCCS structure through both the combat net radio and area common user networks. The secure telephone unit III (STU-III) allows tactical, strategic, and civilian users to access ATCCS through an MSE interface.[51]

Even when these very capable systems are fully fielded, the communications network available will not be "sufficient to support voice, data, and video requirements of the future battlefield."[52] For the U.S. Army, communications remains the weakest link to realizing the objective automated command and control architecture of ABCS. The realities of the communications shortcomings are both qualitative and quantitative.

Current systems capable of handling the tremendous volumes of data required to meet the needs of ABCS are expensive, heavy, and large. Their transmissions are also limited by line-of-sight. The technical limits of size, weight, and transmission significantly impacts their utility in a force projection tactical command post which is required to be mobile.

Cost impacts on the quantity of systems which the Army can afford. Even if the technical issues are resolved, it is unlikely the Army can afford to field the system in

sufficient quantities to support company and battalion size command posts.[53] This level of robustness is required to allow a commander to control his forces from a variety of CP locations. Failure to resolve the communications challenge will constitute a critical shortcoming in the current vision of future battlefield C2.

If these technical and financial obstacles are overcome, the ABCS intends to link tactical, regional, and theater information grids. Eventually even these theater information grids will be linked with each other, and to the NCA, to achieve a global information grid. This global information grid is referred to as an infosphere.[54] "An infosphere provides the warfighter an information highway containing a combination of systems for collecting, processing (fusion), displaying, disseminating, and protecting information."[55]

The ABCS intends to achieve this global networking through a combination of broadcast service, open system standards, common protocols, seamless communications, and wireless wide-area networks (WAN) and local-area networks (LAN). The broadcast systems will automatically update information previously provided by several different systems. Open system standards and common protocols will "allow the Army to interface ...with equipment and products from different sources."[56] Redundant global communications provides access to the infoshere. Wireless WAN and LANs will allow tactical command posts to share information. For the ABCS system to meet its expected capability, this combination of communications systems must provide assured, "comprehensive, and continuous flow of information."[57]

The result of the ABCS architecture is a system which "permits commanders at every level to share a *common, relevant picture* of the battlefield scaled to their level of interest and tailored to their special need."[58] The digitization of the battlefield, and seamless communications will facilitate direct sensor to shooter links. The globally flat information architecture will allow these links, and associated actions, to be viewed simultaneously by commanders and staffs at every level. The integration of environmental effects with the graphic portrayal of near-real time enemy and friendly situations, status reports, and an integrated imagery capability, will facilitate the potential control of current operation execution. By providing a common, relevant picture, the ABCS will offer the commander a comprehensive view of his battlespace, the principle component of situational awareness.[59]

To meet the requirements of the Army's Force XXI concept, the ABCS common relevant picture must manifest four characteristics. Whether sorted at higher command or in the local command post, the system must present data that is tailored to the level of command viewing it. This tailoring requires information to be sorted or fused to the geographic and resolution needs dictated by mission, task, and situation. Tailoring enhances **relevance**. The display of the information must be standardized, and easily understood by the warfighter. This usually means a visual presentation of all critical information, or a **picture**. This standardized, user-friendly display embraces the notion of **commonality.** The final characteristic of the common relevant picture is the **availability** of any information to all users. Lower levels of command may be required to request (pull) information because of limited data links. Upper levels of command

may need to probe the available picture for detail resolution. Penetrating displayed information for greater resolution will often provide clarity about a local situation. Whether availability is achieved through flat architecture, direct linkage, or broadcast access, every echelon must have access to the full range of information.[60]

During C4 systems' historic quest for certainty, "two characteristics have remained constant: the human element and the need for relevant, timely, and accurate information."[61] Notwithstanding the prodigious expectations of the ABCS system's capabilities, as laid out in the Army C2 Master Plan, the Force XXI concept reminds us that, "Soldiers will remain our greatest intelligence source, especially in OOTW, [and] ...Information provided by soldiers must be integrated to confirm, corroborate, or deny the digitally portrayed common picture."[62] The common picture provided by ABCS will "greatly enhance force level dominance by enhancing situational awareness and ensuring rapid, clear communication of orders and intent, potentially reducing the confusion, fog, and friction of battle."[63] But VanCreveld reminds us, "... given the fact that this goal [certainty] has proven elusive through every one of the many revolutions in organization, technology, and procedure that have taken place in the past, there doesn't appear to be much hope of achieving it in the foreseeable future."[64]

Whether the ABCS system can technically accomplish all that is expected of it, and whether future budgets will support the quantities necessary to make the system feasible, are not the critical questions. What is critical is how well Army commanders understand the capabilities and limitations of the system, and how well they use them. "To use existing technologies to the limit and at the same time make its very limits work for one--

surely is the hallmark of genius."[65] The ABCS system provides the technical context within which current thinking about process and procedure is conducted.

Process and Procedure

Leadership is the integrating element of command in battle. Leadership synchronizes the effects of the other three combat functions: maneuver, firepower, and protection.[66] No automated system will be capable of accomplishing that function independently. Face-to-face communication between leader and led is still the most practical way to effect this synchronization. This is especially true of communication between senior military commanders and their subordinates. The nuances of tone, inflection, expression, and body language, expressed while engaged in face-to-face exchanges, convey meaning and lead to understanding. The subordinate can feel the commander's emphasis and hear his concerns. The senior commander can see when his point is understood, and feel apprehension or misgiving in the subordinate. No distant form of communication, yet made possible by technology, has been able to master successfully the influence of this face-to-face interchange.[67]

"To make effective decisions, commanders must formulate and articulate a vision of their unit... This vision begins with the current situation... and goes through the desired conclusion to the operation. ...This concept has implications for all commanders, but is especially applicable to brigade and higher level command."[68] The previous section confirmed that an automated C2 architecture does not, and can not, operate independently of the leader. Standardized procedures and decision making processes supplement automated architectures and help link leaders. These processes and

procedures perform another vital function. They help mitigate the shortcomings of the automation architecture by supplementing information flow, and independently validating the formal system.

The primary tool the commander has at his disposal to assist him with the function of planning, preparation, and control of execution is the staff. The staff's job is to extend the reach of the commander. Through the staff a commander can monitor his entire organization. The staff assists the commander in decision making by synthesizing large quantities of information and presenting it to the commander in the form of products that can be easily interpreted. The use of staffs as tools to decision making, and as information synthesizers, also presents the commander with a few challenges. A staff must be trained. The staff must know how to operate the automation and communication tools of the command and control system. They must be sensitive to the information needs of the commander, and the personal technique he uses to arrive at decisions. For staffs to be effective, the commander must "formulate and articulate a vision for their unit",[69] and provide the critical link to the process by "clearly articulate[ing] his information requirements based on decisions he is required to make."[70]

The wargamming process is the doctrinal technique which compels the staff to think through the critical information the commander will need to make decisions. It also identifies the source and means of delivery associated with each element of information. For this process to work, the staff must understand the amount of uncertainty the commander is willing to accept in making decisions. No matter how effective the staff, or how well they assist the commander in determining what critical

information is needed to track the flow of the operation and make decisions, it is ultimately the commander who must select his critical information requirements based on the amount of uncertainty with which he is comfortable.

Well developed and personally tailored processes and procedures are critical to the efficient linking of a commander and his staff. Decision making processes and procedures must be tailored to the way the senior commander likes to see information presented, and how he goes about making decisions. Like the automated system, no decision making process will ever accomplish completely the perfect transfer of information between staffs. Nor will any procedure lubricate the decision making environment between a commander and his staff to the point where there is no friction or fog. To overcome this decoupling of information flow, there are two doctrinally accepted tools used to increase effectiveness of the formal process. They are: a supplemental system of informal communications between staffs, and a validating channel used by commanders, outside the normal system, known as the directed telescope.

For their part, staffs must remember it is the products of the decision making process that serves the commander. The staff must not get captured by the process or the presentation of the information at the expense of presenting the information clearly, in a timely manner. "Form is less important than substance."[71] The commander is "faced with making tough decisions in complex situations ...in an environment of uncertainty and limited time."[72]

Staffs must cultivate informal lines of communication and avoid being fixated on process. Informal lines of communication with subordinate commanders and staffs are critical. Informal links help lubricate the formal process. Gaps in information, linkages between disparate elements of the plan, and the relative importance or criticality of some minor statement are all examples of the kinds of information informal lines of communication can supplement.

The commander must also be suspicious of the formal process as his sole source of information. The ***directed telescope*** is a tool commander's use to supplement the information gathering of the formal command and control system. The directed telescope is a means, less structured than the formal system, the commander can use at will to gain information tailored to his momentary needs.[73] The specific means can take many forms. Liaison officers, informal staff visits (requirement for the staff to visit units daily), trusted junior officers on subordinate staffs, and command presence forward are a few means that have been used successfully throughout history.[74]

Battle Command

So far we have examined the automated C2 architecture of ABCS and doctrinally accepted formal and informal decision making processes and procedures that supplement the automation. Each of these systems is inadequate to completely prosecute the function of command. The architecture of the automated battle command system is only important to the degree that it facilitates or impedes the function of command. As a component of the overall C2 architecture, ABCS and the doctrinal decision making procedures define the environment in which command is exercised. The environment is

an expression of the limitations of the system. To highlight its importance, doctrine separates the functions of leadership and decision making, in the concept of battle command, from the rest of the C2 infrastructure. . The *art and science of* applying the system, overcoming its limitations, and successfully executing missions through *leadership and decision making is battle command.* After briefly discussing the generic concept of command, and specifically defining battle command, this chapter will focus on describing the elements comprising tactical battle command.

Command embraces two key concepts. The first is the lawful component which identifies the statutory authority a commander exercises over his subordinates by virtue of rank, assignment, or international agreement.[75] The potential for a compressed hierarchy and internetted structures, associated with automated C2, can diffuse command authority and require new leadership and command approaches of many militaries.[76] The second component of command, and the one this monograph concentrates on, involves the art and technique of command. In this context command is "the art of motivation and directing soldiers and their leaders into action to accomplish missions."[77]

Battle command is the art of leadership and decision making to accomplish missions. Control is inherent in battle command.[78] Battle command is exercised during all phases of an operation: planning, preparation, and execution. The emphasis of battle command is on the **execution of missions**. The battle commander is responsible for ensuring the mission is accomplished despite the limitations of the automated and procedural control system. "Battle command is dictated by the commander not his supporting control systems."[79] "The tactical commander's decisions are **focused on the**

execution of a specific mission or plan which engages the enemy within his battlespace..."[80] Army doctrine and the future concepts of Force XXI consider battle command a combat function. FM 100-5 identifies battle command's "two vital components [as] decision making and leadership."[81] The leadership component includes taking responsibility and motivating soldiers. The decision making component involves knowing if to decide, as well as knowing when and what to decide.

Providing *leadership is the fundamental function of battle command.* Military leadership is taking responsibility for decisions, and inspiring and directing assigned forces toward the purposeful end of those decisions. Historically, leadership appears "...to be a crucial variable affecting unit cohesion, discipline, and military effectiveness. [Conversely], one factor virtually guaranteeing poor military performance is bad leadership and its destructive effect on group cohesion."[82] Leadership involves taking responsibility for decisions, motivating soldiers, loyalty to subordinates, directing assigned forces, building cohesive teams, and providing vision.[83]

"A willingness to ***accept responsibility*** is the foremost trait of leadership".[84] The notion that a commander is responsible for all that his unit does or fails to do is an expression of the military ethos of the command responsibility inherent in leadership. Accepting responsibility implies action. The commander is responsible for the action of his unit. Through his will, the battle commander inspires and directs assigned forces and resources to a purposeful end.

It is "the quintessential task of commanders to send men to their deaths."[85] It is critical that the commander to be able to ***motivate his soldiers*** to accomplish the mission.

An indispensable elements of leadership which the battle commander must demonstrate to motivate soldiers is *moral and physical courage*. At lower levels of command, usually company and battalion, the physical nature of courage is the most predominant. At the senior levels of command, above battalion, the requirement to exercise the moral aspects of courage are more common. At every level of command, however, the commander fosters a climate of teamwork that engenders success by demonstrating both moral and physical courage. Commanders are expected to "act with courage, conviction and tenacity in the uncertainty and confusion of battle."[86] This very human dimension to command requires the commander to be seen by the soldiers.

A tangible results of courage demonstrated by the commander are: unit cohesion and teamwork. A unit's combat effectiveness "depends heavily upon the willingness to lead, and this willingness is sustained by the presence of competent, brave officers willing to share risks with their men."[87] The physical presence of a commander, his willingness to accept hardship, and the threat of death, demonstrates loyalty to subordinates. *Loyalty* produces self-less sacrifice that leads to unit cohesion and team work.

The *art of directing action* is a critical subset of military leadership. Decision making is the leader's first step to directing action. Decision making is an inherent task of command. All military commanders must answer the question of what to decide; but, at senior levels, the most important questions involve if and when to decide. To answer any of the decision making questions (knowing if, when, and what to decide) the battle command concept recognizes the need for three leadership abilities. The three attributes

that assist the commander in overcoming the fog of battle and associated limitations of the C2 system environment are: ***battlefield visualization, intuition, and initiative***.

The battle commander must provide a vision that both focuses resources, and anticipates future events. A clear vision that is articulated to the unit is the key ingredient to husbanding resources and providing for success at least cost.[88] For this reason, battlefield visualization "lies at the center of battle command". It is an essential leadership attribute. It nourishes the mental process which supports decision making. The ability to visualize the battlefield is the result of analyzing information made availible through battlefield digitization, making personal observations, and application of intuition gained through experience.

Visualization is the ability of the battle commander to understand the current state of his environment, the desired future end-state, and likely reactions of that environment to his decisions. The commander's ability to conceptualize the salient elements of his environment, their relationships, and the likely consequence of their interaction, is critical to decision making. Technology and battle staffs provide the commander support in the process. But the commander is ultimately responsible for making decisions, based on his understanding, relating to the planning, preparation, and execution of operations. The process of visualization is not a science. It can be cultivated through experience, but the ability to master the art of visualization is personal.[89]

A critical ingredient necessary to master the art of visualization is ***intuition.*** "Intuition is the ability to demonstrate immediate cognition without evident rational thought and inference. ...[It] is the insight that rapidly dismisses the impractical solution

and moves to the feasible course of action."[90] Intuition is nurtured and developed through combat experience, training, and education. It is the very volume of information available through modern technology which makes intuition an invaluable requirement of battle command. "The successful commander requires a *balanced detachment* from the unimportant, with an instinctive recognition of ...what requires his direct involvement."[91] Only by exercising intuitive judgment can the modern commander sift through the volume of conflicting information available to him, to arrive at a decision faster than an enemy can react.[92]

A final component of the Army decision making doctrine is the requirement for commanders at all levels to act. The requirement for action, within the bounds set by the higher commander's intent is known as ***initiative***. As early as the 1941 version of FM 100-5, Army doctrine has stressed the need for soldiers to act--even in the absence of orders. In addition, the early doctrine actually encouraged the subordinate to alter the execution of specific directives when the subordinate no longer believed them relevant to the situation presented to him.[93]

Current doctrine emphasizes the need for intuition to facilitate "...rapid, agile operations emphasizing ingenuity and improvisation..."[94] The doctrine recognizes the need to accept risk, make decisions without perfect information, an act without hesitation. The accumulation of chance errors and unexpected difficulties, which Clausewitz calls friction, requires initiative. This is especially true when communication with higher headquarters is broken, or rendered unfeasible due to battlefield tempo. Doctrine states that a commander must "...act freely and boldly to accomplish his

mission"[95]; and goes on to say that "Others [foreign armies] discard this approach as too risky."[96]

Army doctrine places great emphasis on the *subordinate's role* and responsibility *to exercise initiative*. Very little is offered, in doctrine, about the senior commander's role and responsibility to facilitate the initiative of subordinates. When addressing the subordinate maneuver commander's need for flexibility when in contact, the doctrine admonishes his superiors; "He [the commander in contact] can neither cope with constant direction from above nor can he constantly provide detailed direction to his staff and subordinate commanders."[97]

The senior battle commander must balance carefully the requirement for control with the need for flexibility and initiative by the subordinate. The Army on the modern battlefield is what M. Mitchell Waldrop would call a complex organization. To operate effectively it must self-organize and adapt to the rapidly changing environment. On the battlefield the purpose of command is to direct the organization, though leadership and decision making, along the narrow path that separates chaos from order.[98] "The role of command, ..., increases with the sophistication of forces---...".[99] As our automated architectures become more sophisticated, the criticality of the commander's role is increased - not diminished.

The ABCS architecture assists the commander by employing automated decision aids and then rapidly transmitting those decisions to subordinates for execution. To maintain control over the automated decision aids, the battle commander must determine the parameters of those decisions, and monitor their execution. It is the battle

commander's responsibility to visualize the battlefield clearly and identify the many decisions that could present themselves. He provides the parameters within which independent action (automated or human) will be tolerated. It is critical, at senior levels, for the battle commander to monitor execution in order to determine if and when the conditions of the battlefield exceed the tolerances of the plan. At that point, the commander must be ready to step in to take charge, or change the limiting parameters, in which subordinate action is executed. While it addresses the need for management by exception, or negation, when deciding when to intervene with automated systems, Force XXI doctrine does not specifically address negation as a command technique.

Analysis

An analysis of the Army and Navy systems reveals more similarities than differences. There are three factors of both the Army and Navy systems that lend themselves to analytical comparison. They are: ***philosophy, environment, and command responsibility***. The element of philosophy concerns the institutional disposition toward command by negation. The environment in which command is exercised is the most obvious comparative factor between the Army and Navy systems. An army force is land-based, and diffuse. The Navy is sea-based and centralized. In addition, the Army command platform is generally smaller, lighter, and less pristine than the Navy platform-- a ship. The final significant factor for comparing the Army and Navy systems is the method each uses to apportion command responsibility. The Army delineates command relationships geographically. The Navy delineates command relationships functionally.

A functional command structure may be the most useful factor the Navy system has to offer the Army.

The Army battle ***command philosophy*** emphasizes the need for the subordinate commander to display initiative, within the commander's intent, when executing missions. The responsibility for demonstrating initiative is placed on the subordinate at every level of command. As discuss earlier, this initiative includes: action taken within the framework of the senior commander's concept of the operation, and assertive action taken in the absence of orders, bounded by the senior commander's intent. More controversially, it also endorses taking action contrary to the senior commander's specific guidance (but within his intent) when, in the opinion of the subordinate, the environment has changed sufficiently from the plan to so warrant.

Future battle command concepts, addressed in Force XXI operations, mention the need for senior commanders to exercise command by negation when dealing with the automated decision aids associated with future technology. To be effective, many of the actions resulting from automated decisions must be executed without the encumbrance of man-in-the-loop direction. The most intuitive example of the need for automated decision making is the rapid response time required of the air defense system.

The future concept stops short of providing recommendations to senior commanders about the command by negation philosophy when dealing with subordinates. The future concept recognizes that a senior commander must remove himself from direct decision making on many occasions. The volume of decisions required, and the shortcomings of even the best automated picture of the battlefield,

make central decision-making unrealistic. But the only philosophy proffered by the future battle command concept places the burden of sorting out the execution of operations on subordinate initiative. It does not adequately address the responsibilities of the senior commander, nor does it supply him techniques to facilitate subordinate initiative during the execution of operations.

The Navy CWC concept stresses the use of a command by negation philosophy to senior commanders. Like the Army system, subordinate initiative is mandated. Under the Navy's philosophy, however, the senior commander is responsible for establishing the foundation for subordinate initiative. The senior commander regulates the amount and degree of acceptable subordinate initiative by his actions. The technique of negation (or veto) serves as both a control and an encouragement of subordinate initiative.

The primary difference between the two systems' philosophies is one of emphasis and perspective. The Navy system emphasizes the role of the senior commander in setting up an environment that facilitates subordinate initiative. The Army system emphasizes the subordinate's role in exercising initiative. The Navy perspective is focused on the role of the senior commander. From the Navy perspective, the senior commander drives the degree of control and supervision with which he feels comfortable. The subordinate's ability to exercise initiative is a function of the commander's actions. The Army perspective focuses on the subordinate's responsibility to exercise initiative. The senior Army commander's responsibilities are limited to the procedure of articulating well defined parameters in the form of a commander's intent, during the orders process. The relative emphasis of the Army philosophy on the

subordinate's responsibility to act, and a silence with regard to the senior commander's role, places a disproportionate burden on the subordinate.

The Army commander's intent is critical in the planning and preparation phases of the operation. By formally adopting the Navy's philosophy of command by negation, the Army could institutionalize the role of the senior commander during the execution phase of an operation. Institutionalizing the senior commander's role, would encourage the development of standard techniques the senior commander could employ during the execution of operations to control and encourage subordinate initiative. Further, the formal adoption of a command by negation philosophy would also institutionalize the senior commander's roles and responsibility for establishing an environment conducive to subordinate initiative.

The disparity between the ***environments*** in which the Army and Navy operate pose the greatest practical challenges to the implementation technology of the two C2 architectures. The Army operates on land and only marginally in a third or air dimension, principally governed by another service. Its command and control system is constrained by the limitations of terrain. The Navy operates at sea, and control units that operate under, on, and above the sea. While the sea poses unique challenges to the Navy, the constraints imposed on seaborne C2 technology do not appear as severe as those imposed on terrain based systems.

The Army system is constrained by the limitations imposed by terrain. Terrain directly affects the communication systems that connect the automated technologies located in command post platforms. The weight and bulk of automation and

communications equipment constitutes a technological constraint imposed on land based command post architectures, due to their impact on command post mobility. Finally, the nature of land warfare influences the challenges that must be overcome by any Army C2 architecture.

Terrain imposes a barrier to communications. With the exception of the improved high frequency radio, tactical Army communication is based on line-of-sight systems. To maintain a communication backbone for the automation architecture, terrain imposes a requirement for extensive retransmission or nodal communications architectures. Even space based systems (SCAMP) require a line-of-sight link between the receiver antenna and the satellite. Command posts or tactical units operating in rugged terrain will experience terrain related interruptions in their ability to communicate, no matter what currently available system is employed.

Command post platforms must be mobile in a terrain constrained environment. This imposes limits on the size, weight, and numbers of communications and automated technology equipment available in the command post. Reducing the size and weight of electronic systems technology invariably affects price. The Army must balance the availability of future C2 systems (which is driven by cost) against the requirement for smaller, lighter, more mobile configurations.

Land based operations imply the presence of the elements. Army systems must operate in a wide range of temperature extremes. They must perform their function reliably in the dry and sandy desert, or the wet and humid jungle. Reflection on past and future battlefields brings to mind images of mud, rain, sand, dust, wind, and snow.

The mobility requirements of the C2 platforms mentioned earlier precludes installing all but the most essential pieces of environmental control equipment to mitigate the effect of the elements on future land based C2 equipment.

The nature of land warfare involves controlling a substantially greater number of disparate elements than naval warfare. The marginal utility of knowing the exact location, and activity of every combat soldier and weapon system, on the digitized battlefield, is reached before the absolute goal is realized. The expansive distribution of men and material on the battlefield is a function of modern warfare. Every soldier, and every resource used to support the soldier, is subject to the chaos imposed by dispersed operations and imperfect control.

The Naval system must accommodate each of the environmental challenges described under land warfare. The challenges are mitigated, however, by the maritime warfare environment, and the platforms that allow the Navy mobility at sea. The curvature of the earth posses limitations on line-of-sight communications used at sea. The medium of water also poses challenges to communications with submarines operating below the surface. The moderation of the communications challenge, when compared with land warfare, is the predictability of the environment. The land force must modify all standardized communication plans and command post positioning based on the unique terrain associated with a particular battlefield. The Naval planner can physically arrange a fleet, and implement a standardized communications architecture, based on a terrain independent model.

The platforms used by the Army and Navy to house C2 equipment are substantially different. Army C2 systems are limited in size, weight, and numbers to facilitate vehicular command post mobility over terrain. The Navy's C2 equipment size, weight, and numbers limitations are driven by ship capacity. While Navy ships seem small to those who must live on them for extended periods, they are more spacious command post platforms than Army vehicles. Weight limitations on C2 equipment are less severe than weight limitations on mobile land based platforms. The Navy realizes a cost savings relative to the costs associated with miniaturizing equipment to facilitate land based vehicular transportation.

Like land based systems, Navy C2 systems must overcome the effects of the elements on their operation. In addition to the rain, wind, and temperature factors discuss earlier, sea based systems must withstand the corrosive effects of sea spray and salt. The ship platform mitigates the effects of the environment on C2 equipment. While not pristine, Navy ships generally provide a greater degree of climate control and insulation from the physical affects of the elements than their vehicular mounted land-based counterparts.

Perhaps the most profound element of land based operations that the Navy C2 system does not have to accommodate is dispersion. The Naval system enjoys an inherently greater degree of central control over its weapons platforms and personnel than the Army. Army operations, by their nature, involve a relatively greater number and complexity of moving parts. Synchronization of land-based operations is further complicated by the comparative lack of central control over weapons and individual

soldiers. When a ship's captain directs the helmsman to turn northeast, he can be fairly certain his entire crew will be turning northeast. Even when the full C2 architecture described in the ABCS is fielded, the Army commander will lack the assurance a ship's captain has that his orders will be universally executed by every squad leader in his command. In the Navy, every weapon system can be tied-in and controlled by a central authority. In the Army, every soldier is potentially a weapons system. The quantity, dispersion, and nature of the individual soldier as a weapon make it impossible (and undesirable) to control positively all the weapons of an Army unit from a central location.

The difference between the Army and Navy systems is one of degree. There are greater challenges, and more severe environmental limitations placed on Army C2 system than Navy C2 systems. These challenges will limit the ability of technology to effect the same degree of C2 automation that the Navy system currently enjoys. The Army must rely more on the intuitive ability of battle commanders to overcome the shortcomings of technology, because the Army system will experience more technological shortcomings than the Navy system. The Army system must provide a wider range of basic skills to the individual soldiers, and subordinate commanders, to overcome the friction inherent in the decentralized prosecution of land warfare. It is possible for the challenges associated with land and sea based environments to be overcome by technology, procedure, and training; but the land based system will likely lag behind the sea based system. The limits of technology to overcome all of the land-

based environmental challenges is a further endorsement of institutionalizing a command by negation philosophy in the Army.

There remains the final, and most important, distinction between the Army and Navy systems: the method of delineating ***command responsibility***. The Army delineates command responsibility using battlefield geometry. The Navy delineates command responsibility functionally. The first echelon of functional command under the OTC is the CWC. Under the CWC concept, the Navy further delegates command responsibility functionally to the subordinate warfare commanders.

The Army system views force protection as an inherent function of any tactical mission, and an intrinsic responsibility of command. When the fleet is small enough for the OTC and CWC responsibilities to reside in the same person, the Navy system views force protection in the same way. When the fleet size expands, the Navy creates a distinct and subordinate commander, the CWC, to accomplish the force protection mission. In the Navy's view, the span of control responsibilities of a large fleet impede the OTC's ability to focus on the mission as a whole. If the fleet comes under attack, force protection responsibilities may consume his attention at the expense of the tactical mission. The CWC releases the OTC from the burden of an immediate focus on force protection. This provides the OTC the perspective required to evaluate the immediate threat to the fleet in the context of overall mission accomplishment.

The Navy's functional command organization exploits the technical capabilities of a composite picture environment and its command implications very well. In addition,

joint doctrine encourages functional command saying, "A functional command offers streamlined, centralized command and control of military functions and operations."[100] As technology provides the Army the capabilities of a common relevant picture, as described in the objective ABCS architecture, the Army should consider the implications of adopting a functional command structure.

After discussing changes in the historic relationship between organizational, procedural, and technical means employed by armies, Martin VanCreveld points out that, "a development in any one of them almost always entails a change in the rest."[101] The changes in the technical and procedural means discussed to this point encourage the consideration of changes to organizational structure as well. The Force XXI operations concepts "mandate change to the way we organize."[102] As we explore alternative command methods, the Army should consider a functional command organization design. The resulting organization should be tested using automated simulation, and when ABCS is fully fielded, field training exercises to validate its applicability to the Army. Two questions the Army must consider to validate a functional command architecture model are:

a. What would a functional command architecture model look like?

b. Would a functional command model be useful?

The one caveat to this functional command structure is the absolute requirement to fully field a robust automated command and control system that meets all of the expectations of the ABCS objective architecture. The practicality of a truly non-linear battlefield is based on decentralized prosecution of land warfare at the individual soldier

and small unit level. This can only be achieved if the communications and automation technology provides near perfect information on friendly forces down to the infantry squad and crew served weapon system level of fidelity. Because of technological shortcomings, and fiscal constraints, the realization of a workable functional command organization is a long way off.

Conclusion

Four conclusions emerge from this study in the form of recommendations to the battle labs as they leverage technology and build the Army of tomorrow. First, the Army should ***adopt the concept of command by negation*** as a tenet of battle command doctrine. Force XXI doctrinal concepts focus on the need for subordinate initiative. Adding the concept of negation would guide senior level command efforts to develop techniques to achieve a command climate that encourages subordinate initiative. Further, with the credibility of a doctrinal foundation, command by negation techniques and procedures would be institutionalized. Based on doctrine, senior leaders would develop and share techniques and procedures to accommodate their dual responsibilities of coping with the volumes of information presented by the command and control system, and determine and when to intervene in subordinate activity. Second, the Army should ***resource formalized*** staff structures that afford commanders the tool of ***directed telescopes and robust liaison teams***. Liaison officers and institutional directed telescopes will help commanders avoid the pitfalls associated with overreliance on an impersonal technical control system as the only means of gathering and validating information. While this conclusion is not based strictly on the Naval CWC architecture,

the staff functions officers (submarine element coordinator, air coordinator and electronic warfare coordinator) perform the role of directed telescopes within the CWC system. Third, as technology solves the communications, fusion, artificial intelligence decision making, and human interface, challenges associated with an immature ABCS architecture, the Army should ***test alternative command structures***. The Navy concept of functional commands, and the Army's desire to operate on a non-linear battlefield seem to complement each other. When this concept is tested by the battle labs, the Army may discover that land based and sea based operating environments may be sufficiently different to render functional commands impractical for Army application. Finally, there is the need to ***temper change with the realities of technology and funding limitations***. Before the Army can compare their C2 architecture to the Navy's CWC architecture in the real world, the Army must fund the development and fielding of technology capable of attaining the objective ABCS requirements. Without fielding this technology, the Army's system will not resemble the Navy's capability with sufficient likeness to warrant drawing practical conclusions from the comparison.

End Notes

[1] Gordon R. Sullivan, and Togo D. West, Force XXI...America's Army of the 21st Century (Fort Monroe, VA: Office of the Chief of Staff, Army, 15 January 1995), 3.

[2] TRADOC PAM 525-5, Force XXI Operations: A Concept for the Evolution of Full-Dimensional Operations for the Strategic Army of the Early Twenty-First Century (Fort Monroe, VA: Department of the Army, 1 August 1994), 2-7.

[3] FM 100-5, Operations (Washington, D.C.: Department of the Army, 14 June 1993), 2-3.

[4] FM 100-5, Operations, 2-9 and 2-11.

[5] TRADOC PAM 525-200-1, Battle Command (Fort Monroe, VA: Department of the Army, 1 December 1994), 10.

[6] Joint Pub 3-56, Command and Control Doctrine for Joint Operations (Initial Draft) (Washington, D.C.: Office of the Chairman Joint Chiefs of Staff, September 1992), I-1.

[7] Martin L. VanCreveld, Command in War (Massachusetts: Harvard University Press, 1985), 10.

[8] TRADOC, Army Battle Command Master Plan (ABCMP) (Fort Monroe, VA: Department of the Army, 19 September 1994), 5-15.

[9] Ibid., 1-5.

[10] TRADOC PAM 525-5, Force XXI Operations, 3-20.

[11] Van Creveld, Command in War, 264 - 265.

[12] Ibid., 265.

[13] TRADOC, Army Battle Command Master Plan (ABCMP), 6-2.

[14] FM 100-5, Operations, 1-3.

[15] TRADOC PAM 525-200-1, Battle Command, 9.

[16] TRADOC, Army Battle Command Master Plan (ABCMP), 3-8.

[17] Unless otherwise noted, this section on CWC can be attributed to NWP 10-1, Composite Warfare Commander (CWC) (Washington, D.C.: Department of the Navy, 1985).

[18] Joint Pub 3-56, Command and Control Doctine, III-1.

[19] Joint Pub 3-56, Command and Control Doctrine, IV-12.

[20] NWP 10-1, Composite Warfare Commander (Washington, D.C.: Department of the Navy, 1985), 4-1.

[21] TRADOC PAM 525-5, Force XXI Operations, 3-4.

[22] Dean R. Anderson, "Modernizing Army Command and Control," Military Review (July 1990): 6.

[23] TRADOC, Army Battle Command Master Plan (ABCMP), A-5.

[24] TRADOC, Army Command and Control Master Plan (Volume 1): Desktop Reference, (Fort Leavenworth, KS: Combined Arms Combat Developments Activity, February 1990), chapter 4.

[25] Ibid., section VIII.

[26] Ibid., chapter 5.

[27] General Accounting Office, Battlefield Automation: Army Tactical Command and Control System's Schedule and Cost (Washington , D.C.: National Security and Internal Affairs Division, September 1992), 10.

[28] Ibid., 2.

[29] VanCreveld, Command in War. VanCreveld develops the failures associated with relying on automation in chapter 5 using WWI and the disaster at the Somme as historic vignettes to support his arguments. He further traces the influences of the complexity inherent in technology advancements, particularly in regard to automation in C2, and a heightened desire for control all the way to the NCA due to the advent of nuclear weapons, in chapter 7. The following quote captures the essence of the chapter: "...during the two decades after 1945, several factors came together and caused the American armed forces to undergo an unprecedented process of centralization. In the first place, there was the revolutionary explosion of electronic communications and automatic data processing equipment, which made effective worldwide command and control from Washington a practical technological proposition. Second, there was the preoccupation during the 1950's with the need for failproof positive control systems to prevent an accidental outbreak of nuclear war, preoccupation that led first to the establishment of the World Wide Military Command and Control system (WWMCCS) in 1962..." 237.

[30] Joint Pub 6-0, Doctrine for Command, Control, Communications, and Computer (C4) systems support to joint operations (Washington, D.C.: Director of Operational Plans and Interoperability, J-7, 30 May 1995), II-1.

[31] FM 100-5, Operations, 2-12.

[32] Joint Pub 6-0, Doctrine for C4 systems, ix.

[33] Ibid., I-4 to I-5.

[34] VanCreveld, Command in War, 8.

[35] TRADOC PAM 525-70, Battlefield Visualization Concept (Fort Monroe, VA: Department of the Army, 1 October 1995), 4.

[36] TRADOC, Army Battle Command Master Plan (ABCMP), 4-20.

[37] DOD Directive 4630.5 (referenced by Joint Pub 6-0, p. III-1).

[38] Edward G. Anderson III, Memorandum for Commander, United States Army Training and Doctrine Command, SUBJECT: Army Battle Command Master Plan (ABCMP), 19 September 1994.

[39] TRADOC, Army Battle Command Master Plan (ABCMP), 4-15.

[40] Operational Requirements Document (ORD) Army Battle Command System (ABCS): Applications and Common Operating Environment (Draft) (Fort Leavenworth, KS: TPIO-ABCS, undated), 1.

[41] Joint Pub 6-0, Doctrine for C4 systems, xiii.

[42] TRADOC PAM 525-70, Battlefield Visualization Consept, 4.

[43] Sullivan, America's Army of the 21st Century, 24.

[44] Joint Pub 6-0, Doctrine for C4 systems, II-3.

[45] TRADOC, Army Battle Command Master Plan (ABCMP), 4-4.

[46] Joint Pub 6-0, Doctrine for C4 systems, xiii.

[47] TRADOC PAM 525-5, Force XXI Operations, 3-10.

[48] Joint Pub 6-0, Doctrine for C4 systems, xiii.

[49] TRADOC, Army Battle Command Master Plan , 3-15.

[50] FM 100-5, Operations, 2-15.

[51] TRADOC, Army Battle Command Master (ABCMP), 6-2.

[52] TRADOC PAM 525-70, Battlefield Visualization, 4.

[53] The author extrapolates this conclusion from the September 1992 General Accounting Office report on Battlefield Automation cited earlier.

[54] Joint Pub 6-0, Doctrine for C4 systems, II-4.

[55] TRADOC, Army Battle Command Master Plan (ABCMP), 5-4

[56] Ibid., 5-12.

[57] Ibid, 5-11.

[58] TRADOC PAM 525-5, Force XXI Operation, 3-4.

[59] TRADOC, Army Battle Command Master Plan , 4-12.

[60] The elements of this paragraph were synthesized from Joint Pub 6-0, "Doctrine for C4 Systems Support to Joint Operations" (Washington, D.C.: Chairman of the Joint Chiefs of Staff, 30 May 1995), I-5, figure I-4.

[61] Joint Pub 6-0, Doctrine for C4 systems, I-1.

[62] TRADOC PAM 525-5, Force XXI Operation, 3-6.

[63] Ibid., 3-5 and 3-6.

[64] VanCreveld, Command in War, 266.

[65] Ibid., 59.

[66] TRADOC PAM 525-5-200-1, Battle Command, 4.

[67] VanCrevald, Command in War, 263. VanCrevald called this "...the most important aspect of command. The informal, and sometimes tacit, communications that goes on inside and organization; its vital, but ultimately undefinable, ability to distinguish between relevant and irrelevant information fed to it: the mental processes that, often unknown event to himself, do take place inside a commander's head; the tone of voice with which a report is delivered, or an order issued; the look on a man's face, the glimmer in his eye, when handed this or that message--none of these would be recorded."

[68] TRADOC PAM 525-5, Force XXI Operations, 2.

[69] TRADOC PAM 525-70, Battlefield Visualization Concept, 2.

[70] TRADOC, Army Battle Command Master Plan (ABCMP), 5-7.

[71] TRADOC PAM 525-5-200-1, Battle Command, 10.

[72] Joint Pub 6-0, Doctrine for C4 systems, I-1.

[73] VanCreveld, Command in War, 75 and 272.

[74] Van Creveld also mentioned some senior commanders finding these information gathering so critical that they diverted whole units to the activity. Specifically he cites Patton using the cavalry, and Montgomery building a phantom system of liaison officers.

[75] Joint Pub 3-56, Command and Control Doctrine, I-6.

[76] TRADOC PAM 525-5, Force XXI Operations, 2-8.

[77] FM 100-5, Operations, 2-14.

[78] Ibid., 2-15.

[79] TRADOC PAM 525-200-1, Battle Command, 12.

[80] Ibid., 9.

[81] FM 100-5, Operations, 2-14.

[82] Richard A. Gabriel and Paul L. Savage, Crisis in Command: Mismanagement in the Army (Toronto, Canada: McGraw-Hill Ryerson, 1978), 50 - 51.

[83] FM 100-5, Operations, 2-15.

[84] Ibid., 24.

[85] Van Creveld, Command in War, 16.

[86] TRADOC PAM 525-200-1, Battle Command, 10.

[87] Gabriel, Crisis in Command, 23.

[88] FM 100-5, Operations, 2-5. This paragraph is derived from the definition of leadership.

[89] TRADOC PAM 525-70, Battlefield Visualization Concept, 3,5, and 6.

[90] TRADOC PAM 525-200-1, Battle Command, 4.

[91] Ibid.

[92] VanCreveld, Command in War, 267. VanCreveld expands on this point and illuminates the "self-defeating dilemma" a commander finds himself in when he waits for more information. The commander finds himself unable to distinguish between the "relevant and the irrelevant, the important from the unimportant, the reliable and the unreliable, the true and the false."

[93] FM 100-5, Operations, (Washington, D.C.: Department of the Army, 22 May 1941), 24. Note: all references to FM 100-5 are 1993 unless full citation is used.

[94] FM 100-5, Operations, 5-2.

[95] Ibid.

[96] Ibid., 2-5.

[97] Ibid., 2-15.

[98] M. Mitchell Waldrop, Complexity: the emerging science at the edge of order and chaos (New York: A Touchstone Book, Simon & Schuster, 1992). 12.

[99] Van Creveld, Command in War, 6.

[100] Joint Pub 3-56, Command and Control Doctrine, IV-2.

[101] Van Creveld, Command in War, 10.

[102] TRADOC PAM 525-5, Force XXI Operations, 4-5.

Acronym Glossary

AAWC	Anti-Air Warfare Commander
ABCS	Army Battle Command System
ACCS	Army Command and Control System
ADO	Army Digitization Officer
AFATDS	Advanced Field Artillery Tactical Data System
AMPS	Aviation Mission Planning System
AREC	Air Coordination Element
ASAS	All Source Analysis System
ASUWC	Anti-Surface Warfare Commander
ASWC	Anti-Submarine Warfare Commander
ATCCS	Army Tactical Command and Control System
AWIS	Army WWMCCS Information System
BFA	Battlefield Functional Area
C2	Command and Control
C2I	Command, Control and Intelligence
C3	Command, Control and Communications
C4	Command, Control, Communications and Computers
CB	Citizen Band
CHS	Common Hardware Software
COTS	Commercial Off-the-Shelf Technology
CP	Command Post

CSSCS	Combat Service Support Control System
CWC	Composite Warfare Commander
DOD	Department of Defense
EPLRS	Enhanced Position Location and Reporting System
EWC	Electronic Warfare Coordinator
FAADS	Forward Area Air Defense System
FAAD C2I	Forward Area Air Defense Command, Control and Intelligence System
FLCS	Force Level Control System
FM	Field Manual or Frequency Modulation
GCCS	Global Command and Control System
HEC	Helicopter Element Coordinator
IHFRS	Improved High-Frequency Radio System
IVIS	Integrated Vehicular Information System
JP	Joint Publication
JTIDS	Joint Tactical Information Distribution System
LAN	Local Area Network
MCS	Maneuver Control System
MSE	Mobile Subscriber Equipment
NWP	Naval Warfare Publication
OTC	Officer in Tactical Command
SC	Screen Commander

SCAMP	Single Channel Anti-Jam Man Portable
SEC	Submarine Element Coordinator
SINCGARS	Single-Channel Ground and Airborne Radio System
STU	Secure Telephone
SWC	Subordinate Warfare Commander
TACFIRE	Tactical Fire Direction System
TRADOC	Training and Doctrine Command
WAN	Wide Area Network
WWMCCS	Worldwide Military Command and Control System

BIBLIOGRAPHY

Books:

Boyes, Jon L. Principles of Command and Control. Washington, D.C.: AFCEA International Press, 1987.

Clausewitz, Carl Von. On War. Ed. and Tr. Michael Howard and Peter Paret. Princeton, New Jersey: Princeton University Press, 1976.

Cohen, Eliot A. and Gooch, John. Military Misfortunes. New York: The Free Press, 1990.

Forester, C. S. The General. London: Heineman Educational Books, Ltd., 1963.

Hammond, K.R. Decision Making in Action: Models and Methods. Norwood, NJ: Ablex, 1993.

Kahn, James P. and Worley, Robert D. Understanding Commander's Information Needs. Santa Monica, CA: RAND Corporation, 1989.

Keegan, John. The Face of Battle. Harmondsworth, England: Penguin Books, 1976.

Keegan, John. Mask of Command. New York: Penguin, 1987.

Marshall, S.L.A. Men Against Fire. Gloucester Massachusetts, 1978. (Chap 7 & 8)

Peters, Thomas J. Thriving on Chaos. New York: Harper and Row, 1987.

Meltzer, Morton F. Information: The Ultimate Management Resource. New York: AMACOM, 1981.

Moran, Charles. Anatomy of Courage. Garden City Park, New York: Avery Publishing Group, 1987.

Slim, William. Defeat into Victor. London: Cassell and Company, 1956.

Van Creveld, Martin. Command in War. Cambridge, Massachusetts: Harvard University Press, 1985.

Waldrop, M. Mitchell. Complexity. New York: Simon & Schuster, A Touchstone Book, 1992.

Wooodward, Sandy. Hundred Days: The Memoirs of the Faulklands Battle Group Commander. Annapolis, Maryland: Naval Institute Press, 1992.

Military Publications (Essays and Monographs):

Cox, Robert D. "Information Pathology and the Army Tactical Command and Control System (ATCCS): Is ATCCS the Cure?" Fort Leavenworth, KS: School of Advanced Military Studies Monograph, 31 Dec 1990.

Griffin, Gary B. "The Directed Telescope: A Traditional Element of Effective Command" Fort Leavenworth, KS: Combat Studies Institute, 1985.

Hastings, Thomas M. III. "Command Relationships in Amphibious Operations: The Integration of Composite Warfare and the Expeditionary Forces." Newport, RI: Naval War College, 19 June 1992.

Johnson, Scott T. "Strike Warfare commander's Role in Amphibious Assault." Newport, RI: Naval War College, 1990.

Jordan, Thomas M., "Is Decentralized Command and Control of Tactical Maneuver Units a Myth or Reality?" Fort Leavenworth: School of Advanced Military Studies Monograph, 20 Dec 1991.

Kahan, James P., Worley, D. Robert, and Stasz, Cathleen. "Understanding Commanders' Information Needs." Santa Monica, CA: RAND Corporation, June 1989.

West, Togo D. and Sullivan, Gordon R. "Force XXI: Meeting the 21st Century Challenge." Fort Monroe, VA: Office of the Chief of Staff, Army, 15 January 1995.

Articles:

Anderson, Dean R. "Modernizing Army Command and Control." Military Review vol. LXX, no.7 (July 1990): 2-10.

Bell, Carl H. III (Colonel). "The Standard Theater Army Command and Control system of the Future." Military Review June 1994: 79-82.

Bolger, Daniel P. "Command or Control?" Military Review vol. LXX, no. 7 (Jul 1990): 69-79.

Boyd, Moris J. (BG) and Woodgerd, Michael (MAJ). "Information Operations--Force XXI Operations" Military Review vol. 74, no.11 (Nov 1994): 17-28.

Cherry, Timothy D. (Major). "Future Command and Control Systems." Armor November 1994: 16-18.

Collins, A.S. "Tactical command." Parameters September 1978: 78-86.

Collins, J.L. "Leadership at Higher Echelons." Military Review vol. LXX, no. 5 (May 1990): 33-45.

Cushman, John H. "Joint Command and Control." Military Review vol. 74, no.11 (Nov 1994): 25-34.

Giordano, Robert F. "Tactical C3: The Key to Tomorrow's Battle." Electronic Defense. February 1989: 36-38.

Hughes, David. "Army Selects Sanders Mission Planning System." Aviation Week and Space Technology 26 September 1994: 80-81.

Hultman, Evan. "Command and Control - Key Issues." Armor March 1989: 24-29.

Kind, Peter A. "Army Tactical C2 System." Military Review vol. LXX, no. 7 (July 1990): 35-41.

Kirkland, Faris R. "Combat Leadership Styles: Empowerment versus Authoritarianism." Parameters December, 1990: 61-72.

Knudson, Wayne. "The Future of C2." Military Review vol. LXX, no. 7 (July 1990): 18-24.

Krenzel, Robert S. Jr. (1LT). "The Armor Lieutenant and the M1A2." Armor July-August 1995: 15-22.

Less, Tony. "JTFME: CWC Doctrine at Work." Joint Doctrine Development and Review Newsletter Winter 1990: 1, 5.

Madigan, James C. (MAJ) and Dodge, George E. (MAJ). "Battle Command: A XXI Imperative" Military Review vol. LXXIV, no. 11 (November 1994): 29-39.

McGinnis, Michael L. "Decision Support Technology" Military Review vol. LXXIV, no. 11 (November 1994): 68-74.

Munro, Neil. "Is ATCCS headed Back to the Drawing Board?" Army Times 15 March 1993: 32.

Nordwall, Bruce D.. "Small GPS Receivers Open New Possibilities." Aviation Week and Space Technology 5 December 1994: 57-58.

Pierce, Terry C. "Who's in Charge." Naval Institute Proceedings August 1991: 32-37.

Schneider, Derek C. (Captain). "Combat Vehicle Command and Control." Armor July-August 1994: 40-42.

Slim, William. "Higher Command in War." Military Review vol. LXX, no. 5 (May 1990): 10-21.

Wishart, L.P. "Leader Development and Command and Control" Military Review vol. LXX, no. 7 (July 1990): 11-17.

Field Manuals, Regulations and Reports:

Army Battle Command Master Plan: 1994. Washington, D.C.: Department of the Army, 19 September 1994.

Army Command and Control Master Plan (U) Vol I. Fort Leavenworth, KS: Combined Arms Combat Developments Activity (CACDA), 1990.

Army Command and Control Master Plan (U) Executive Summary. Fort Leavenworth, KS: Combined Arms Combat Developments Activity (CACDA), 1990.

Army Tactical command and Control system (ATCCS) Umbrella Concept for Battalion and Below Command and Control (B2C2) (3d Draft). Fort Leavenworth, KS: Combined Arms Combat Developments Activity (CACDA), 7 July 1992.

Battle Command Concept (draft) Fort Leavenworth, KS: Battle Command Battle Laboratory (BCBL), November1993.

Battle Command Techniques and Proceedures: A Commander's Guide for the Coordination and Execution of Battlefield Operating Systems. (1st Coordinating Draft) Fort Leavenworth, KS: Battle Command Battle Laboratory (BCBL), 21 April 1995.

Battlefield Automation: Army Tactical Command and Control System's Schedule and Cost, Washington, D.C.: General Accounting Office. 25 September 1992.

Battlefield Visualization Concept, Fort Monroe, VA: Training and Doctrine Command. 1 October 1995.

Center for Army Lessons Learned, "Battalion and Brigade Battle Staff Lessons Learned", Draft Bulletin Vol I. Fort Leavenworth, KS : Oct 1990.

FC 101-55 Corps and Division Command and Control. Fort Leavenworth, KS: U.S. Army Command and General Staff College, March 1987.

FM 22-100 Military Leadership. Fort Leavenworth, KS: Combined Arms Center, July 1990.

FM 22-103 Leadership and Command at Senior Levels. Fort Leavenworth, KS: Combined Arms Center, June 1987.

FM 100-5 Operations. Fort Leavenworth, KS: Combined Arms Center, June 1993.

Joint Pub 3-56 Command and Control Doctrine for Joint Operations (Initial Draft). Washington, D.C.: Office of the Joint Chiefs of Staff, September 1992.

Joint Pub 5-0 Doctrine for Planning Joint Operations. Washington, D.C.: Office of the Joint Chiefs of Staff, 13 April 1995.

Joint Pub 6-0 Doctrine for Command, Control, Communications, and Computer (C4) Systems Support to Joint Operations. Washington, D.C.: Office of the Joint Chiefs of Staff, 30 May 1995.

Lussier, James W., Saxon, Terrill f. "Critical Factors in the Art of Battle Command", Study Report 95-01, U.S. Army Research Institute for the Behavioral and Social Sciences, Nov 1994.

NWP 8 Command and Control. (U) Washington, D.C.: Department of the Navy, May 1985. CONFIDENTIAL

NWP 10-1 Composite Warfare Commander's Manual . (U) Washington, D.C.: Department of the Navy, June 1985. CONFIDENTIAL

Operational Requirements Document (ORD) Army Battle Command System (ABCS): Applications and Common Operating Environment. Future Battle Labs, Fort Leavenworth Kansas, Draft dated September 1995.

TRADOC PAM 525-5, Force XXI Operatioins: A Concept for the Evolution of Full-Dimensional Operations for the Strategic Army of the Early Twenty First Century, Fort Leavenworth, KS. 1 August 1994.

TRADOC PAM 525-100-1, Leadership and Command on the Battlefield: Operations JUST CAUSE and DESERT STORM, Fort Leavenworth, KS. 1992.

TRADOC PAM 525-200-1, Battle Command, Fort Leavenworth, KS. 1 December 1994.

U.S. Department of Defense, Dictionary of Military and Associated Terms. Washington, D.C.: The Joint Chiefs of Staff, 1 January 1986.